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No. V.

*On the Geographical Distribution of Plants. By C. Pickering, M.D.—Read October 19th 1827.*

**T**HE observations of travellers in every part of the globe, and our greatly increased knowledge of the species both of vegetables and animals, have of late years brought forward the interesting subject of their geographical distribution. The materials accumulated prior to the last half century were few, and insufficient to solve many questions which have since yielded to the labours of naturalists. Much has been accomplished by Humboldt, Brown, Schouw and others—the subject is continually receiving increased attention, but it is uniformly rendered intricate by attempting to reduce under the same laws both species and groups (as families, genera, &c.), while it is evident that the local causes, which, in the one instance, greatly influence their distribution, by no means affect the other. In this essay, species and groups are examined separately, the inquiry is directed more particularly to the former, and their range is followed as a guide in the arrangement here proposed.

Solar heat is evidently the principle which puts in motion the fluids of plants, and these vary in their relation to it, some requiring a temperature that destroys others; consequently, a plant being carried far north or south of its natural

station meets a climate fatal to it, from a deficiency or excess of heat, marking its northern and southern limits.

A plant can thus exist only within two belts encircling the globe, one in the northern, the other in the southern hemisphere, in general coinciding with the parallels of latitude, but rendered irregular by the variation of climate at different meridians, elevation of the earth's surface, &c.

The breadth of these belts varies greatly in different species, and though experience has sufficiently demonstrated that it may be determined to within one degree of latitude, this has not yet been fully accomplished in a single instance. A careful examination of North American plants, and a comparison of authorities have yielded the following result. In a great part, perhaps one third, of the North American species, it does not exceed five degrees of latitude, and rarely attains twenty.

The range of plants is, however, far from being as extensive as *climate* would permit. The plants of the northern and southern hemispheres are different; the same may be said with respect to the plants of the eastern and western continents, except in the extreme north. Hence we must seek for some other cause restricting the diffusion of plants, and this will be found in the ocean, a great extent of which at once prevents farther progress.

Again, few plants stretch across the whole extent of the continents, in their wider parts, their range is usually still more limited. This leads to the examination of other causes which impede their diffusion.

By ascending above the level of the ocean, the temperature is found to be reduced in the same manner as on advancing towards the poles, and at the height of perpetual snow we find a polar climate. The relative mean proportion has been estimated at about six hundred feet of elevation to a degree of latitude. Accordingly, if a chain of mountains extends in the direction of the meridians, plants of cold regions, meeting a parity of climate, descend on their summits into lower latitudes. On the Rocky mountains, arctic plants reach the nor-

thern provinces of Mexico. Magellanic plants likewise exist on the Andes of Chili. In the southern parts of the United States, the low ridge of the Alleghanies (which rarely exceeds three thousand feet of elevation) affords a multitude of plants which avoid the low country, and are otherwise confined to the northern states.

Mountains thus introduce seeming confusion into our floras, while there exists in reality the most perfect order.

A lofty and unbroken chain likewise presents a barrier insurmountable to many plants. There is much difference in the vegetation between the northern and southern sides of the European Alps—the flora of Chili differs essentially from that of the country on the opposite side of the Andes.

A great river is also an obstacle to the diffusion of plants, apparently less easily overcome than a much more considerable extent of ocean. Many plants on either side of the Mississippi do not cross it. The great rivers of Siberia are known to exert a like influence on vegetation.

Water, with those substances it dissolves in the soil, is the the food of plants, and the quantity they require for the performance of their functions varies in different species. A plant can vegetate only in a soil containing a certain proportion of moisture. The seeds of aquatics will not germinate unless beneath the surface of water, while some plants flourish only in the most arid sands.

Difference in soil, so far as vegetation is concerned, is known to consist mainly in the quantity of water it is capable of absorbing, and its power of resisting evaporation, two qualities dependant on a variety of circumstances:—on the character of the rocks from which the mineral part is derived, whether such as resist decomposition, or yield to it, forming clay; or such as break down into gravel and sand, &c.—on locality, whether on plains and the summits of hills, or on declivities moistened by the filtering of water from higher places, or in low grounds perpetually saturated with it, thus forming marshes and bogs;—whether in the vicinity of, or at a dis-

tance from mountains;—whether exposed to the rays of the sun, or protected by forests, &c.

This relation of plants to water\* confines them to particular situations, and any one plant can occupy but a small portion of the surface of the soil, while at the same time a great number of species can exist together within a limited space. Under certain circumstances, this may have considerable influence upon their range.

These phenomena, with many others which are continually presenting themselves, carry us at once to the supposition, that each species must have originated on a particular point of the earth's surface, from which, in the course of successive generations, it would have spread over the whole globe, but that it has been kept back and confined within narrow limits, by causes, of which the above mentioned are the most prominent. We find accordingly, that almost every practical botanist, conversant with the subject, has followed, often unconsciously, a mode of reasoning which ultimately leads to this conclusion.

That no species has originated on two different points of the earth's surface is proved by a variety of circumstances: most of the instances where a plant occurs in two distant and seemingly insulated places being readily accounted for by existing causes.

There has been much discussion relative to the quadrupeds common to the eastern and western continents; but it is now admitted, that those species only are *common*, whose range extends near to, or within, the arctic circle where the two continents closely approach each other.

The foregoing conclusion is also confirmed by the vegetation of islands. In those which are situated at the distance of from one to several miles from the main land, all the plants are common to the neighbouring continent; while if at a greater distance, they frequently afford some species not to be

\* Maritime plants are confined to a soil impregnated with muriate of soda, and a few species appear to be peculiar to limestone rocks.

found there: and lastly, countries separated by a vast extent of ocean, and at the same time insulated by climate, do not possess in common a single phœnogamous plant\*—as, the southern extremity of Africa with that of New Holland, or of South America.

Among the principal agents in conveying the seeds of plants to a distance from their original site, are the winds, and the currents of the ocean.

The seeds of West Indian plants are thrown by the gulf stream upon the coast of Northern Europe, and sometimes germinate there, but are destroyed by the frosts on the approach of winter. Accordingly, those species, which are common to countries separated by a great extent of ocean, are observed to be generally aquatic and marsh plants, especially maritime, whose seeds are formed to bear a long exposure to water.

Some estimate of the influence of the winds in distributing the seeds of vegetables may be formed, from the fact of the ashes of a volcano being frequently carried many hundred miles from its crater. Botanists have observed that the cryptogamia, especially lichens, in their geographical distribution, do not appear to follow the same laws with phœnogamous plants, many of the former being found in every part of the globe.—The excessive minuteness of the seeds of these plants authorizes the conjecture, that the winds alone have accomplished such an universal distribution.

The fact of the European Alps affording on their summits some arctic plants is not so readily disposed of, as the general direction of this chain of mountains is parallel with the equator, and there is a wide interval, of several hundred miles, between their most northern bend and the southern extremity of the mountains of the Scandinavian peninsula. Here, with the exception of the annual migration of birds, the winds appear to be the only agents left us, and it seems improbable

\* Exceptions are extremely rare: among fifty thousand phœnogamous plants, now known, *Samolus valerandi* is the only well authenticated instance of a plant, which is common to almost every part of the globe.

that they should have conveyed the seeds of plants to *so great* a distance.—The Andes, in this respect, present a striking contrast with the mountains of the eastern continent. This great chain of mountains appears to extend, almost uninterruptedly, from near, or within, the arctic circle to Cape Horn; and arctic plants, which in the eastern continent do not reach the European Alps, have been here discovered as low as 40° N. lat., far south of those mountains—as, *Campanula uniflora*, *Saxifraga nivalis*, &c.

Great confusion has been occasioned in our floras by man himself carrying with him, in his migrations, a multitude of plants. In the more settled parts of the United States, the greater portion of the entire surface is covered with European vegetables: many have even wandered into the woods, so as frequently to perplex the botanist in determining, whether they have been introduced from Europe, or existed here previous to the discovery of the country. The flora of Pursh, which is usually appealed to as giving evidence of the number of species common to the two continents, contains upwards of one hundred and fifty species, now generally admitted by American botanists to have been introduced, but on which that author does not express an opinion, leaving the foreigner without any means of deciding, except that, being frequently indicated as found about fields and cultivated ground, they are of course liable to suspicion.

Thus, climate and the ocean are the two great powers which set bounds to the diffusion of plants, and at the same time, by insulating certain portions of land, divide the surface of the globe into several great botanical regions.

In this essay the following division has been adopted:

I. Greenland, Iceland, and the arctic regions of both continents.

II. The temperate portion of North America.

III. The temperate portion of the Eastern continent.

IV. The West Indies, and the intertropical regions of America.

V. Madagascar and the islands in the vicinity, the inter-tropical regions of Africa and of Arabia.

VI. The intertropical regions of Asia (Arabia excepted), of New Holland, the East Indies, New Guinea, New Caledonia, and most of the islands in the Pacific.

VII. The temperate portion of South America.

VIII. The southern extremity of Africa.

IX. Van Dieman's land, and the temperate portion of New Holland.

X. New Zealand.

XI. The Falkland Islands, Terra del Fuego, the South Shetland Islands, and the southern extremity of South America.

Some volcanic islands are situated in the midst of the ocean, at a vast distance from land, and are so completely insulated, that they cannot be referred to any of the above regions:—such are the islands of Ascension, St Helena, Tristan d'Acunha, in the Atlantic; Amsterdam Island in the Indian Ocean, &c. The flora of islands of this description is restricted in the number of species, but highly deserving attention; and it would even appear that they possess species peculiar to themselves, an extremely interesting and important fact.

All the plants existing in either of the eleven regions here laid down are not invariably confined to it, a few being common to two or more of them; and we observe that if two of these regions approach each other at any point, several species are common to both;—thus, many species are to be found in the northern parts of the two continents, and in the intertropical parts of Africa and of Asia:—while to those which are most completely separated, no phœnogamous plant is common.

As the plan refers solely to the range of plants, it is liable to the objection of elevating a comparatively insignificant portion of southern Africa to the rank of a distinct region, while the whole of the northern and temperate part of the eastern continent, comprising more than a third of all the land upon the surface of the earth, forms but one; and if the in-



intermediate portion of this continent had been originally covered by the ocean, the eastern and western extremities, according to the present system, would undoubtedly have ranked as two botanical regions: but, the land being continuous, plants have so intermingled that it is impossible to draw a line of distinction.

As few plants are diffused over the whole of the more extensive of these regions, subregions may be established, and the principal rivers and chains of mountains should be employed for that purpose as the natural boundaries, each subregion containing many peculiar species. This has been attempted in the second and third regions only.

The second region comprises four subregions:

1. *Flora Canadensis*. All Canada, from the Atlantic to the Pacific, and bounded south by the rivers Oregon, Missouri, and St Lawrence.

2. *Flora of the United States*. The country situated between the Atlantic and the Mississippi river.

3. *Flora Ludoviciana*. The country situated between the Mississippi and the northern Andes.

4. *Flora Californiana*. The country situated between the northern Andes and the Pacific.

The third region comprises six subregions:

1. *Flora Europea*. The north of Europe and western Siberia, bounded east by the river Yenisei, and south by the chain of the Alps, of Caucasus, &c.

2. *Flora Siberica*. The country situated between the Yenisei and the Pacific.

3. *Flora Mediterranea*. The south of Europe and north of Africa.

4. *Flora Persica*. Persia, Syria and the north of Arabia, bounded east by the Indus.

5. *Flora Thibetana*. Thibet and the north of Hindostan.

6. *Flora Chinensis*. China, Corea and the islands of Japan.

These four last do not correspond precisely with the three southern subregions of North America; as on the fortieth pa-

rallel of latitude, this continent, in breadth, hardly exceeds one third of the eastern.

It is not our purpose to examine in detail the geographical distribution of *forms*. In general, the intertropical regions should be contrasted with the remainder of the globe, and thus all forms will be either intertropical or extratropical.—The *Palmae*, *Scitamineæ*, *Musaceæ*, *Bromeliaceæ*, *Aurantiaceæ*, *Guttiferæ*, *Sapotæ*, *Piperaceæ*, *Malpighiaceæ*, *Melastomææ*, *Meliaceæ*, &c. are intertropical forms.—The *Rhododendraceæ*, *Ericææ*, *Saxifrageæ*, *Umbelliferæ*, *Amentaceæ*, *Coniferæ*, *Proteaceæ*, *Epacrideæ*, *Rosaceæ*, *Geraniaceæ*, *Caryophyllææ*, *Cistineæ*, *Cruciferæ*, *Ranunculaceæ*, &c. are extratropical forms.

Again, the northern and southern regions of the globe may be contrasted.—The *Proteaceæ*, *Epacrideæ*, &c. are peculiar to the southern; the *Cistineæ*, &c. to the northern portions of it.

Descending from superior to inferior group, we observe a continual tendency to become restricted to some one of the above botanical regions:—to some of which, entire natural orders are limited, and where orders are not, families or tribes are: descending still lower, many genera are found to be peculiar to each; and even if a genus be not so far restricted, a natural section of it, or some peculiarity in structure or habit, is frequently confined to one region. These facts are deserving of the greatest attention: it is to be observed, however, that from analogy of structure, a like relation to climate might be expected.

On the same principles, maps of the geographical distribution of quadrupeds, birds, reptiles, fishes, mollusca, crustacea, insects, &c. may be constructed; each of which classes will require particular modifications.

Thus, examining the distribution of land quadrupeds, we observe that their range is not so much influenced by temperature, as that of plants, and more so by the ocean:—unlike the seeds of plants, they cannot pass a great extent of water, while at the same time they roam through more degrees

of latitude. For this reason, the intertropical position of New Holland must be restored to the remainder of this continent;—the northern part of Africa should, perhaps, be united with the intertropical part;—Madagascar, from the number of peculiar species, may deserve the rank of a distinct region, while New Zealand is almost a blank in the geography of land quadrupeds.

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On the accompanying map of North America, the ranges of several plants are delineated. It is to be considered merely a sketch; as a large portion of the country has not yet been visited by a botanist, and even in those parts which are best known, observations are either unpublished, or too few to determine, with exactness, the range of a single species. Under these circumstances, we are forced, in some instances, to substitute conjecture for fact.

*The southern boundary of the arctic plants.* In the eastern part of this continent, these plants cannot descend lower than lat.  $44^{\circ}$ , on account of the inferior altitude of the Alleghany mountains south of that line. How low they descend on the northern Andes is not yet ascertained.—The following have been observed at the stations indicated on the map, *Rumex digynus*, *Silene acaulis*, *Polygonum viviparum*, *Trisetum subspicatum*, &c.

The coloured portion represents a fragment of a belt, beyond which certain plants cannot exist, and the irregularities and inflections into which it is thrown in this continent, by the inequality of climate and elevation of the surface: the transverse lines mark the cessation of certain species.—Thus, a few species do not appear to extend west of the Alleghanies;—others are confined to the summits of these mountains, as *Pinus pungens*, *Rhododendron Catawbiense*, *R. minus*, *Diphylleia cymosa*, *Pachysandra procumbens*, *Aconitum uncinatum*, *Galax aphylla*, &c.—westward of the Alleghanies, plants occur which do not reach the Atlantic;—

many are confined between the Mississippi and the northern Andes, as different species of *Pentstemon*, *Eriogonum*, *Psoralea*, *Gaura*, *Ænothera*, &c.—the summits of these mountains again present peculiar species:—the country west of this chain affords others still different, and some in the more northern parts, which are common to eastern Siberia.

Of maritime plants, some are peculiar to America, as *Uniola maritima*, *Spartina glabra*, *Gerardia maritima*, *Aster subulatus*, *A. sparsiflorus*, *Solidago lævigata*, *Uniola spicata*, &c.—while others are common to the eastern and western continents, as *Arundo arenaria*, *Salsola kali*, *Pisum maritimum*, *Glaux maritima*, *Statice Limonium*, &c.

